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Cabbage plant infected with yellows (left) and healthy plant. Both two months old and of the same variety.

The Yellows Disease of Cabbage in Southwest Virginia

BY

F. D. FROMME

BLACKSBURG, MONTGOMERY COUNTY, VIRGINIA

FIG. 1.—*View of a portion of the cabbage test plats showing arrangement of varieties and injury caused by yellows in the susceptible varieties. Each variety occupies two rows. Photographed August 12.*

THE YELLOWS DISEASE OF CABBAGE IN SOUTHWEST VIRGINIA

By F. D. Fromme, *Plant Pathologist*[1]

The disease of cabbage which is known as yellows is prevalent in the commercial cabbage section of southwest Virginia. It was found to be present on nearly all farms in this section in a survey made in 1920 and 1921, the losses amounting to 25 per cent of the crop in a number of fields; 80 and 90 per cent losses being seen in a few cases. An example of the more

Figure 2.—*A commercial field of cabbage near Crockett, Virginia, in which 80 per cent of the plants have been killed by yellows. The variety is All Head Early. Photographed August* 11.

severe cases is shown in figure 2. It seems probable that the yield of cabbage for the section as a whole is reduced as much as 25 or 30 per cent each year by this disease.

Yellows has apparently been present in this section for a number of years since many farmers have had the experience of seeing some of their best land become so "sick" that cabbage production was no longer profitable on it. It is probably true that nearly 50 per cent of the best cabbage land in the section has been abandoned for cabbage production owing to

[1]The writer wishes to acknowledge the assistance of R. C. Thomas, Assistant Plant Pathologist in Extension, in this work.

its having become infested with yellows. Such land produces good yields of corn, wheat, hay and other non-susceptible crops; it is "sick" only for cabbage production.

Yellows is most prevalent in bottom land, the reason being that the bottoms are most suited to cabbage growing and are, therefore, likely to be cropped with cabbage frequently enough to allow the yellows fungus to become generally distributed in the soil. It is probable that a proper system of rotation at the start would have prevented such a thorough infestation as now exists in many fields, but the practice of rotation in a field that has become infested is of little or no avail. Experience shows that yellows persists in the soil almost indefinitely, certainly for a much longer period than that of the average rotation.

The situation in the southwest cabbage section is of serious importance. Much of the best cabbage land is now infested with yellows and the uninfested land is gradually being invaded. If the production of cabbage is to be maintained on its present scale a remedy must be sought and applied. There is no practical method of ridding the soil of this pest, but a still better means of control is at hand; varieties of cabbage resistant to the disease have been developed. These varieties produce good crops in "sick" land on which the ordinary commercial varieties are failures. The Department of Plant Pathology of the Wisconsin Agricultural Experiment Station has developed several of these yellows-resistant varieties by selection. This bulletin describes tests made with two of these during the season of 1921 in the southwest Virginia section.[2]

Appearance of Yellows

Yellows is caused by a fungous parasite which is known technically as *Fusarium conglutinans*. It is usually called "blight" by growers in Virginia. As the name indicates, the presence of the disease is shown by a yellowing and dwarfing of the affected plants. (See frontispiece.) Many of the plants in "sick" land die in the first few weeks of growth, others persist for some time as stunted yellow plants which finally drop their leaves leaving a blackened stub in the hill. A smaller number of the infected plants may survive until harvest but these do not as a rule produce marketable heads. The bottom leaves on such plants drop, leaving a naked stem topped by a small inferior head, as shown in A, figure 4. When the

[2]The acreage in cabbage in the southwest Virginia section, which comprises parts of Wythe and Smyth counties, was 2460 in 1921. The average yield in 1920 was 12.2 tons per acre. Harvest in the section begins in July and extends into October, the bulk of the crop being cut during August and September. This section is unique in that most of the crop is grown from seed sown directly in the field, transplanting from a seed-bed being practiced to only a slight extent.

FIGURE 3.—*Contrast between a yellows-resistant and a non-resistant, commercial-strain of cabbage in the test plats at Marion. Each variety occupies two rows. Photographed August* 12.

midrib of the leaf of a diseased plant or the stem is cut across, the vascular bundles, which carry the water supply of the plant, will be found brown in color, in sharp contrast to the condition in healthy plants. Diseased plants which have made considerable growth are firmly rooted; the roots do not decay except from other causes.

Yellows should not be confused with other diseases of cabbage which are present to some extent in this section. Black-leg is characterized by a wilting of the plant, the leaves usually taking on a purple tint. The plant pulls easily and the base of the stem is found to be blackened and the roots decayed. The leaves do not fall as in yellows but wilt and remain attached

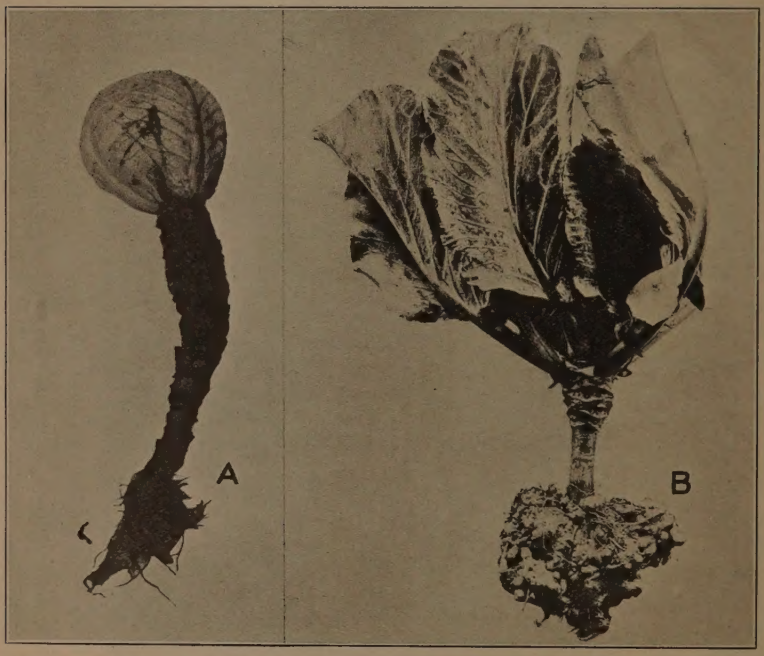

FIGURE 4. A.—*The naked stem caused by the dropping of leaves is typical of yellows infection.* B.—*A cabbage plant infected with club-root.*

to the stem. Black-leg is found in a majority of the fields in this section but is usually of slight importance as compared to yellows. The loss on the average is probably not in excess of 5 per cent. Black-rot is also present to some extent but is relatively unimportant as a rule. It generally appears after the plants have headed, infection beginning at the margin of the leaf

and progressing towards the stem, the infected tissue becoming yellow and the veins dark. In favorable weather a diseased plant may wilt and die in a few days. Club-root is occasionally found but is of slight importance as a rule. It is easily recognized by the swollen condition of the roots (figure 4B). Control measures for these diseases will be discussed later.

Location and Arrangement of Test Plats

The tests were conducted on the farm of Mr. C. P. Groseclose[3] near Marion, Virginia, during the season of 1921. The field used was selected on account of the severity of the yellows infestation as shown by the 1920 crop when 80 per cent was lost from this disease.

Four varieties of cabbage were used in the tests, two of these, Wisconsin Hollander and Wisconsin All Seasons, being yellows-resistant strains which had been developed by the Wisconsin Agricultural Experiment Station.[4] Seed of these were obtained from Dr. J. C. Walker of Madison, Wisconsin. The other two varieties, All Head Early and Copenhagen Market, were commercial strains commonly grown in the locality. The seed of all varieties, after treatment with corrosive sublimate were planted in the field on May 2. In order to insure uniform exposure the four varieties were planted in a series of two rows each (210 feet long) and the series was replicated four times. The order of arrangement may be seen in figure 1. The hills were spaced 18x36 inches and the plants were thinned to one in each hill. Each variety occupied $\frac{525}{4356}$ of an acre, or slightly more than $\frac{1}{8}$ of an acre.

Results of the Test

A uniform stand was obtained with all varieties. The commercial strains soon showed signs of disease and within a month many of the plants had died from yellows. After two months the stand of the commercial strains was only about 50 per cent, and in three months, just before harvest, only one-fourth of their original stand remained. The death of plants is well shown by the large bare spaces in figures 1 and 3. The resistant varieties, in sharp contrast to the others, made a vigorous growth from the start and their stand at harvest was almost perfect. The condition of the four varieties on August 12, shortly before the harvest of the earliest va-

[3]The writer gratefully acknowledges the assistance rendered by Mr. Groseclose and Mr. Lee M. Cole, Jr. County Agent of Smyth County, also the co-operation of the United States Department of Agriculture and the Wisconsin Agricultural Experiment Station through Dr. J. C. Walker.

[4]These strains were obtained by selecting from commercial strains of Hollander (also known as Danish Ball Head) and All Seasons the heads which remained free from yellows on uniformly infested soil. Seed from such heads were found to produce plants much more resistant than the original strains. The first selections of the Hollander cabbage were made by the Wisconsin Agricultural Experiment Station in 1910 and those of All Seasons in 1915. See Research Bulletin 48 of the Wisconsin Agricultural Experiment Station.

rieties, is shown in table 1. Under percentage killed by yellows are included all the plants which died during the season; the percentage infected with yellows includes all plants that died and also those that were living at harvest but were infected. Only 15 per cent of the plants of the commercial strains escaped infection as compared with 94 per cent of Wisconsin All Seasons and 89 per cent of Wisconsin Hollander.

TABLE 1. —*Condition of commercial and yellows-resistant strains of cabbage on August* 12

VARIETY	KILLED BY YELLOWS	INFECTED WITH YELLOWS
	per cent	*per cent*
All Head Early	75	85
Copenhagen Market	72	85
Wisconsin Hollander	4	11
Wisconsin All Seasons	3	6

The harvest data, table 2, show under the column, pounds per plat, the yield of marketable cabbage from the eight rows of each variety, and also the computed yield in tons per acre. The great superiority of the two

TABLE 2.—*Harvest data from cabbage yellows test*

VARIETY	POUNDS PER PLAT	TONS PER ACRE
All Head Early	450	1.9
Copenhagen Market	780	3.2
Wisconsin All Seasons	3815	15.8
Wisconsin Hollander	2855	11.8

yellows-resistant strains is most strikingly shown;—Wisconsin All Seasons yielding approximately 8 times as much as All Head Early and 5 times as much as Copenhagen Market, while Wisconsin Hollander did almost as well.

In addition to the two plats on the Groseclose farm, small test plantings of the two resistant varieties were made by two other cabbage growers in the vicinity. Mr. J. A. Arney secured an excellent yield with both varieties on land that he considered severely infested with yellows. No other strains were, however, used for comparison. Mr. I. D. Snyder's experience was equally favorable, the resistant varieties produced a good yield, very few of the plants being infected with yellows, while the commercial strains grown beside them were severely attacked by yellows.

The Use of Yellows-Resistant Varieties in Virginia

From the tests described in the foregoing it seems to be well established that the strains of cabbage known as Wisconsin All Seasons and Wisconsin Hollander are very resistant to the yellows disease under southwest Virginia conditions, and that these varieties may be grown successfully on land in which the varieties now in use are commercial failures. The fact that the acreage suitable for cabbage production in this section is quite restricted and that much of the best land has been invaded by the yellows organism make the results of these tests of great practical importance to the growers of that section. The general opinion of the growers who visited the test field was that of the two varieties the All Seasons selection most nearly approaches the type best suited to the market demands of the locality. It is quite similar to All Head Early, the variety now most extensively grown, but is slightly later in maturity. Wisconsin Hollander may be satisfactorily substituted for the Danish Ball Head, which is grown much less extensively than All Head Early, although it also requires a longer season than the strains of Danish in common use. This Experiment Station has undertaken selection work on All Head Early and will attempt to develop a yellows-resistant strain of this variety which will fill the needs for an early maturing cabbage of this type.

Recommendations for the Control of Cabbage Diseases

The yellows disease, as shown in this bulletin, can be satisfactorily controlled by the use of resistant varieties of cabbage. The cabbage grower may guard against losses from other diseases of cabbage by the following measures:

A three- or four-year rotation should be practiced, avoiding other crops which belong to the cabbage family, such as rutabaga, cauliflower, kale, collards, turnip and mustard.

The purchase of plants from another state or locality is to be discouraged since diseases may be introduced in this way. Evidence of the introduction of both yellows and black-leg into Virginia through the purchase of plants from other states has been obtained in several instances. Drainage water and refuse from diseased cabbage fields may also carry infection to non-infested land.

Cabbage seed should be disinfected before planting by soaking for 30 minutes in a 1 to 1,000 solution of corrosive sublimate. Follow this by washing in water for a short period and dry thoroughly if they are to be stored. The treated seed should be placed in a new, clean bag.

Club-root may be avoided by liming the soil. If loss from this disease is anticipated apply slaked lime, preferably in the fall, at the rate of about 75 bushels per acre.